

Reducing Thermal Impact in Voltage Standards

Harwell

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Harwell uses VFR's VSMP Z-Foil and FRSM Z1-Foil Ultra High Precision Surface Mount Chip Resistors to create a range of ovenless, economical DC Voltage Standards for use in the laboratory or by the electronics enthusiast.®

Industry/Application Area: Test and measurement instrumentation

Product Used:

- FRSM Series (Z1 Foil Technology)
- VSMP Series (Z Foil)

The Challenge

Voltage standards are commonly used in test, metrology, and aerospace applications as a calibration artifact to reference a known voltage. Measured and calibrated before delivery, standards must exude stability in both long-term and temperature drift as customers require ppm accuracy, providing a challenge for the manufacturer. While the best temperature stabilized Zener voltage references offer temperature coefficients of 0.05-0.5 ppm/°C, it is the ancillary circuitry that can easily contribute voltage shifts of several ppm mainly due to thermally related phenomena such as with the thermocouple effect and temperature coefficients in resistors and analog components that set Zener current and voltage amplification gain.

A practical solution that most manufacturers have implemented to reduce the impact of thermally related voltage shifts is to ovenize thermally sensitive circuitry. This provides virtually guaranteed thermal stability over a wide range of operating temperatures, however at a cost of size, portability, and warm-up time. Current costs for metrological grade voltage standards begin in the thousands of dollars and are limited to rack or shelf-based systems.



The Solution

Harwell, a bespoke manufacturer of test and measurement instruments, has created a thermally stable solution by combining the very best in Buried Zener voltage reference technology with VFR's VSMP Z-Foil and FRSM Z1-Foil Ultra High Precision Surface Mount Chip Resistors to create a range of economical and practical DC Voltage Standards in several accuracies for use in the laboratory or by a maker in environmental temperatures of 18-30°C.



Figure 1: Harwell VR-3 DC Reference

The User Explains

Zener based references for use in precision standards require extremely stable current sources. Research and close consultation with the Zener reference's manufacturer



indicated that the only solution to implementing a non-ovenized design was with Harwell's four-stage power source combined with an ultra-low temperature coefficient resistor creating the most stable current source they could design. VFR's Bulk Metal® Foil resistor technology was so critical that there was no other manufacturer that made a commercially available solution with equal or even close performance.

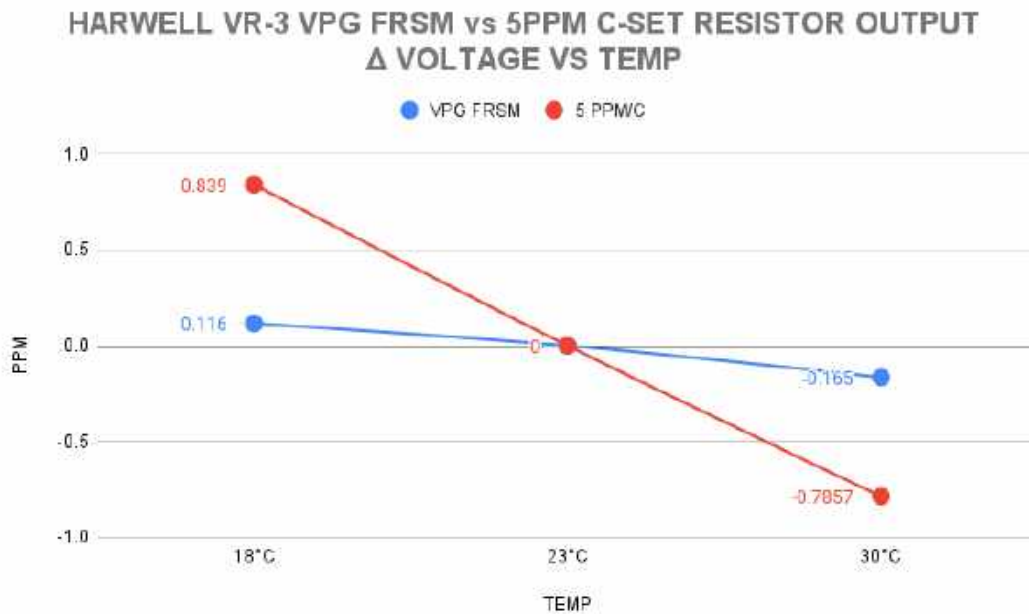


Figure 2: Resistor comparison performance chart

Zener references typically have a nominal output voltage of 7 V which is not conducive to the calibration workflow. References must first be filtered and then amplified or trimmed to typical voltages of 10 V, 1 V, 5 V, or anywhere in-between depending on the end-user's requirement. A traditional resistor set gain amplifier encounters the same thermal issues as before resulting in gain error from the resistor's temperature coefficients, with possible non-linear gain in the event of TCR mismatch. By utilizing VFR's ultra-low temperature coefficient resistors for all of the gain set resistors, gain error was significantly reduced and output stability ensured throughout the instrument's operating range. More importantly, output stability became more linear in relation to temperature thanks to the similar substrates and materials used in VFR resistors.



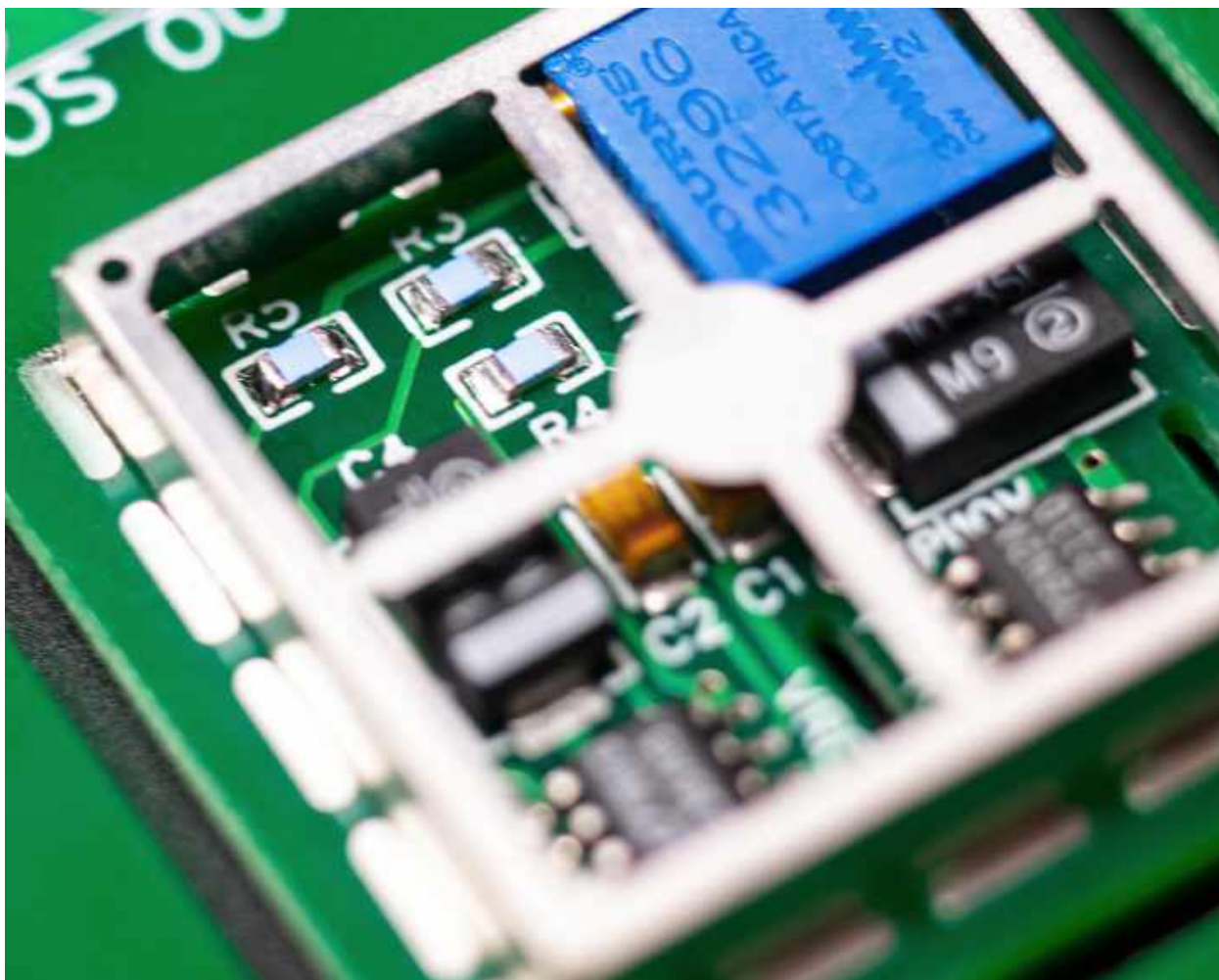


Figure 3: VSMP used in the Harwell VR-5 5 V DC Reference

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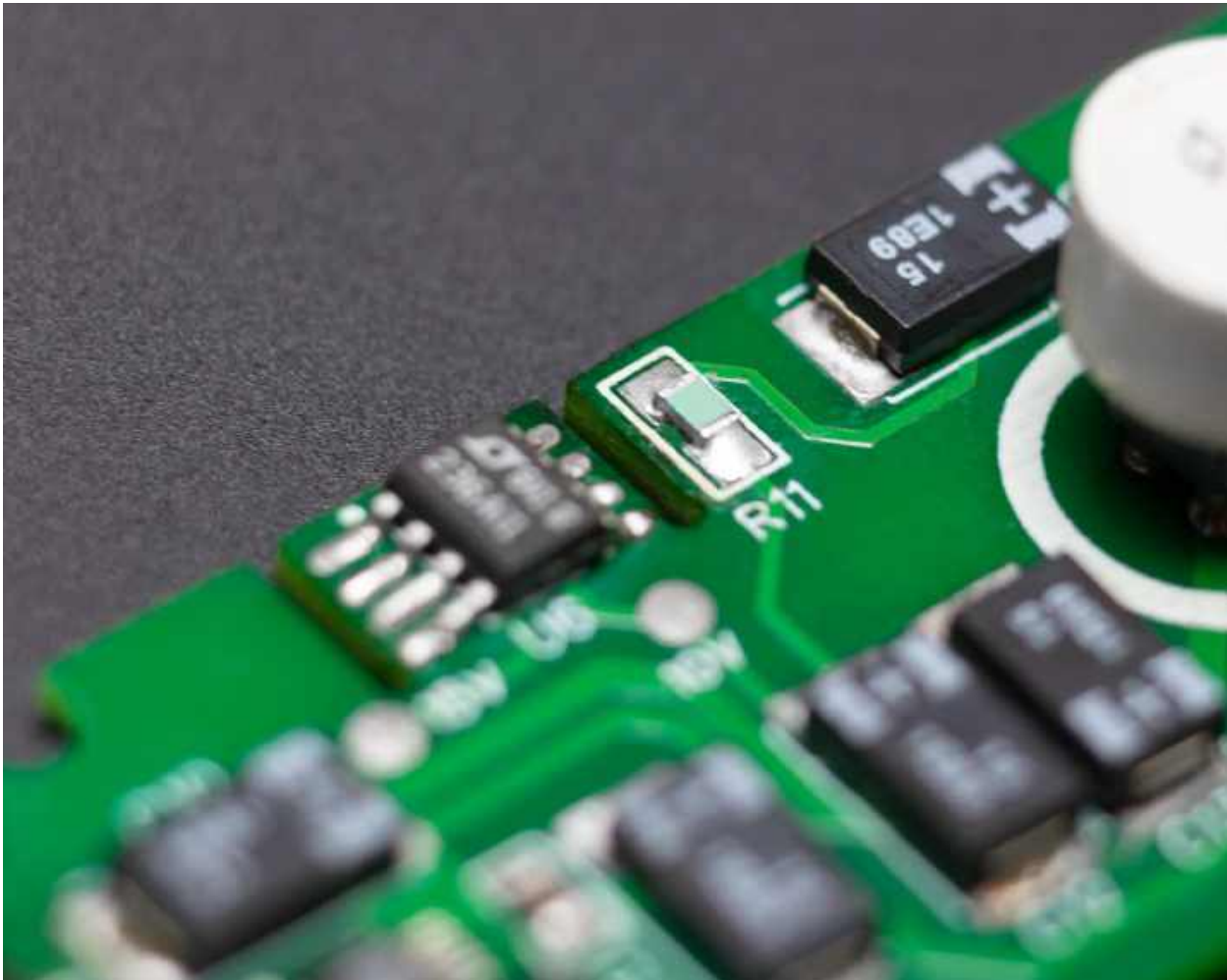


Figure 4: FRSM used in the Harwell VR-3 10 V DC Reference

Acknowledgement

Harwell is a bespoke manufacturer of test & measurement equipment specializing in voltage references, thermometry readouts, and software

VPG Foil Resistors
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